

star image as slightly less intense than the primary star. The differences are small, and may be partly due to local photographic effects.

The images have been measured and the positions and distances determined for plates 536, 2567, and 2889 as follows:—

536	1894.75	94.7	3.55
2567	1907.54	93.7	3.51
2889	1911.97	92.0	3.72

The centennial Proper Motion deduced from plates 536 and 2889 for $+29^{\circ} 65' 13.8''$ is $4''.7$.

Catalogue of Radiant-Points of Shooting Stars, 1898–1915.

By A. King.

The present paper embodies the principal results of my observations of meteors in the years 1898–1915. The paths were recorded chiefly at Leicester and in North Lincolnshire, but many observations were made in Scotland, Holland, and elsewhere.

In the description of each shower, in many cases more details have been included than is usually done. It seemed to me that this will not only be of assistance to future observers in that very difficult department of the work—the assigning of individual meteors to their correct centres—but may also help to throw some light on the vexed question of stationary radiation.

Some radiants are described as “diffuse.” A diffuse radiant may be caused by one or both of two things—

1. Incorrect observation of individual paths, or errors on the globe or chart used in projection.
2. A cause inherent in the shower itself. The Andromedids and the Quadrantids are well known in this respect.

The names in the last column are, with three exceptions, those of Denning's General Catalogue.

Several of the radiants determined in the early part of the work have been discarded. I had not then had so much experience in the observation of meteors, and on reconsideration found the positions hardly substantiated. Nearly all the early radiants have been reprojected, both on a celestial globe and on a meteor-chart, so that the revised positions sometimes differ from those previously published.

No radiant found from less than five paths has been included unless warranted by the undoubted identity of the meteors and the accuracy of their observation.

In some cases the year of observation is not stated. This indicates that the meteors were recorded in various years.

No.	Position.		No. of Mete- ors.	Dates of Observation.	Description.	Name.
	R.A.	Decl.				
1	3	+25½	9	July 26-Aug. 21, 1903	Very swift. Well-defined max., Aug. 21	α Andromedids *
2	4	+35	6	July 22-Aug. 14, 1901- 3-4.	Very swift; somewhat long. One headed, with a spark tail. Most active in Aug.	π Andromedids
3	9	+48	7	July 28-Aug. 14, 1899	Rather swift	α Cassiopeids
4	18	+59	10	July 31-Aug. 13, 1899	Short; streaks	δ Cassiopeids
5	25	+62½				
6	19	+58				
			5	July 13-Aug. 14, 1904	Swift; shortish. Streaks? White? Radiant very definite	„
7	26	+59	5	July 24-Aug. 14, 1903	Swift; shortish; reddish. No streaks	„
8	22	+42	13	July 28-Aug. 14, 1899	Swift; streaks. Somewhat long	γ Andromedids
9	22	+44	5	July 29-Aug. 12, 1900	Very swift; ruddy. One streaked	„
10	23	+42	7	July 21-Aug. 15, 1909- 15	Very swift. Mostly Aug. 12-15	„
11	26	+44	5	Sept. 21, 1901	Swift. Two meteors headed	„
12	26	+44	6	Aug. 3-12, 1904	Very swift; brightish; streaks	„
13	24	+50	6	July 26, 1904, and Aug. 9-12, 1901-3	Rather faint; swift	54 Andromedids†
14	25	+50	6	Aug. 9-11, 1899	Swift; streaks	„
15	28	+70½	5	July 28-Aug. 21, 1900- 3	Short; swift	50 Cassiopeids
16	28	+71½	5	July 21, Aug. 11-25, 1904, 1909-11	Quick; very short	„
17	30	+47	5	July 23-Aug. 11, 1900- 2	Rather swift; bluish; streaks. Rather bright; some headed and trained. Radiant well defined	θ Perseids
18	33½	+18½	12	Oct. 8-Nov. 20, 1898- 99 and 1906-8.	Slowish; somewhat long. Trains? Greenish; mostly in Oct. Radiant well marked	α Arietids
19	40	+38½	10	Sept. 27-Oct. 8, 1899	Swift; streaks; rather short. Max. Oct. 2	β Perseids
20	41	+40	6	Oct. 30-Nov. 6, 1899	Rather swift. Streaks? One trained	„

* Denning's " α Andromedids" consist of two showers, one at $3^{\circ}+27^{\circ}$ and the other at $5^{\circ}+20^{\circ}$. It is the first of these, previously observed only by Mr. Denning himself, which is under consideration here.

† I think this centre, intermediate in position betwixt the δ Cassiopeids ($19^{\circ}+58^{\circ}$) and the γ Androms. ($24^{\circ}+43^{\circ}$), is distinct from either. The star 54 Andromedæ is almost at radiant, hence name given here. In 1901-4 the radiant was precise and the meteors well observed.

No.	Position.		No. of Mete- ors.	Dates of Observation.	Description.	Name.
	R. A.	Decl.				
21	$41\frac{1}{2}$	39°	4	Aug. 3 and 11, 1904	Pale blue; small pear-shaped heads; trains with central bright points; swift. One streaked. Meteors not bright. Radiant very exact. Max. Aug. 11	β Perseids
22	43	+21	9	July 13-Aug. 21, 1899-1907	Longish paths; heads; trains; streaks. Very swift. Radiant diffuse	ϵ Arietids
	$\alpha.$	$\delta.$				
23	39°	+4	4	Sept. 27-Nov. 6, 1899	Moderate, greenish	α Cetids
24	44	+56	7	Sept. 6-21, 1901	Very swift	η Perseids

The Great Perseid Shower.

25	25	+52	4	July 27, 1910-11	Swift; streaks	Perseids
26	28	+53	4	July 27-28, 1902	„ „	„
27	34	+55 $\frac{1}{2}$	6	Aug. 3, 1903	Veryswift; streaks	„
28	35 $\frac{1}{2}$	+56 $\frac{1}{2}$	5	„ 3, 1911	„ „ brightish	„
29	36	+57	7	„ 4, 1903	„ „	„
30	38	+56 $\frac{1}{2}$	10	„ 6, 1904	„ „	„
31	42	+57	4	„ 9, 1902	Swift; streaks	„
32	44	+57	11	„ 9, 1899	„ „	„
33	44	+58	9	„ 10, 1902	Very swift; streaks	„
34	44	+57	7	„ 10, 1909	Swift; streaks	„
35	44	+56 $\frac{1}{2}$	6	„ 10, 1915	„ „	„
36	45	+57	29	„ 10, 1899	Veryswift; streaks	„
37	46 $\frac{1}{2}$	+57	14	„ 11, 1901	„ „	„
38	45 $\frac{1}{2}$	+57 $\frac{1}{2}$	32	„ 11, 1904	„ „ bright	„
39	45	+56 $\frac{1}{2}$	17	„ 11, 1909	„ „	„
40	45	+59	7	„ 11, 1914	„ „ brightish	„
41	46	+57	20	„ 11, 1899	„ „	„
42	48	+58	12	„ 12, 1900	„ „ bright	„
43	47	+58	13	„ 12, 1901	„ „ rather bright	„
44	48	+56 $\frac{1}{2}$	6	„ 12, 1902	„ „	„
45	46 $\frac{1}{2}$	+57 $\frac{1}{2}$	13	„ 12, 1904	„ „ bright	„
46	47	+58	6	„ 12, 1909	Swift; streaks	„
47	46	+56 $\frac{1}{2}$	9	„ 12, 1914	Veryswift; streaks. Mostly bright	„
48	48	+58 $\frac{1}{2}$	14	„ 12, 1915	Swift; streaks	„
49	48	+58	7	„ 12, 1899	Very swift; streaks; bright	„
50	47	+58 $\frac{1}{2}$	7	„ 13, 1914	Bright; swift; streaks	„

No.	Position.		No. of Mete- ors.	Dates of Observation.	Description.	Name.	
	α .	δ .					
51	48	+58½	7	,, 13, 1915	Swift ; streaks	Perseids	
52	49	+57	6	,, 13, 1899	,, ,,	,,	
53	48	+59½	6	,, 14, 1903	,, ,, brightish	,,	
54	50½	+58½	4	,, 14, 1904	Very swift ; streaks	,,	
55	48	+58	5	,, 14, 1914	Swift ; streaks	,,	
56	50	+59	3	,, 14, 1899	,, ,, definite	,,	
57	51	+58	4	,, 15, 1901	,, ,, bright	,,	
58	45	+64	5	Aug. 8-11, 1899	Swift ; streaks. Bright. Trains ?	P. III. Camelids	94
59	50	+20½	4	Oct. 30-Nov. 6, 1899	Bright ; slow	ζ Arietids	
60	58	+8	8	Oct. 28-Dec. 16	Starlike ; slowish. Mostly long, bright and trained. Radiant well marked	e Taurids	
61	60½	+59½	7	Aug. 8-14, 1904	Swift ; streaks. Some bright. Radiant definite	P. III. Camelids	208
62	61	+58	12	July 28-Aug. 14, 1899	Max. Aug. 8-14. Very swift ; brightish ; streaks. Many were headed	,,	
63	61	+59	5	Aug. 4-21, 1900	Max. Aug. 21, swift	,,	
64	61	+59	7	Aug. 10-13, 1909-15	Swift ; streaks. Several headed. Two trained, in which cases no streaks. Mostly yellow. Radiant definite	,,	
65	61	+48½	6	Aug. 11, 12, 1901	Very swift ; streaks. Two were headed	μ Perseids	
66	61	+47½	7	Aug. 10-19, 1903-15	Very swift ; streaks. Brightish. One trained. ? White. Radiant definite	,,	
67	70	+17½	4	Dec. 1, 3, 1902	Short ; rather swift. Radiant well defined	o Orionids	
68	73	+53	13	July 29, 30, and Aug. 9-13, 1899	Swift ; streaks. Three headed, one trained. Well-defined max. Aug. 12	8 Camelids	
69	75	+42	5	Aug. 4-21, 1903	Swift ; streaks	α Aurigids	
70	75	+41	7	Aug. 15 - Sept. 21, 1900-1	Swift ; streaks. Mostly headed. Radiant diffuse	,,	
71	75	+41	9	Aug. 9-Sept. 25	Very swift ; streaks. Rather bright. Mostly headed and white	,,	
72	91	+16	4	Oct. 18, 1900-1	Swift ; streaks. Rather bright	Orionids	
73	91½	+15	4	Oct. 22, 1898	Very swift ; streaks	,,	
74	109	+31	4	Dec. 8-13, 1899-1900	Short ; rather swift	Geminids	

No.	Position.		No. of Mete- ors.	Dates of Observation.	Description.	Name.
	α .	δ .				
75	111	+33 $\frac{1}{2}$	6	Dec. 13, 1906	Short; swift	Geminids
76	121	+32	5	Dec. 7-13, 1908, 1909, 1915	Slowish; some trained. Rather bright. Mostly greenish and starlike	β Geminids
77	130	+20	4	Nov. 8, etc., 1898, 1899	Long paths. Moderate	δ Cancerids
78	148 $\frac{1}{2}$	+22	10	Nov. 15, 1903	Very swift; bright; streaks	Leonids
79	150	+23	5	Nov. 14, 15, 1903	Swift; bright; streaks *	,,
80	150 $\frac{1}{2}$	+21	8	Nov. 15, 1904	Bright; swift; streaks. Two were headed, long- ish and trained	,,
81	151	+23	7	Nov. 8-17, 1900-15	Long paths. Very swift; brightish; streaks	,,
82	151 $\frac{1}{2}$	+22	7	Nov. 15, 1899	Very swift; streaks. Bright	,,
83	151 $\frac{1}{2}$	+22	3	Nov. 15, 1900	Very swift; paths rather long. Radiant well de- fined	,,
84	216	-26	5	Apr. 11-24, 1903	Rather swift; bright; long †	Hydrids
85	228	+52	8	Jan. 3, 1903	Moderate; trained; long	Quadrantids
86	232	+53	8	Jan. 3, 1910	Brightish. Moderate; long. Streaks. One trained. Radiant diffuse	,,
87	236 $\frac{1}{2}$	+51 $\frac{1}{2}$	4	Apr. 19, 1903	Short; rather swift. Radi- ant. Well defined	τ Herculids?
88	256 $\frac{1}{2}$	+37	6	Apr. 19-22, 1903	Swift. Well defined max.; Apr. 22	π Herculids
89	266	+26	7	Apr. 20-21, 1900	Faint; rather swift	97 Herculids
90	271	+77 $\frac{1}{2}$	4	July 26-Aug. 21, 1900- 3	Slowish; mostly faint; greenish?	ψ Draconids
91	271 $\frac{1}{2}$	+33	12	Apr. 21-22, 1903	Swift; streaks. Many were headed	Lyrids
92	274	+33	6	Apr. 20-21, 1900	Rather swift; streaks. Whitish	,,
93	283	+63	6	July 27-Aug. 10, 1902	Rather short; very swift	δ Draconids
94	286	-12	7	July 13-Aug. 16	Slowish; bright; stellar	λ Aquilids
95	299	+54	4	Aug. 7-15, 1904	Very swift. Radiant well defined	33 Cygnids
96	299	+56	12	July (end)-Aug. (beg.) 1911	Very swift. Radiant dif- fuse, but centre well marked	,,

* A reprojection of some of the best paths recorded during the great shower of 1903.

† This radiant, which has shown activity only in recent years, was first determined by Professor Herschel, from paths recorded by various observers in 1900 April 16-21, at 218°-31° (*M.N.*, Feb. 1901, p. 247). The position here given is the first individually determined.

No.	Position.		No. of Mete- ors.	Dates of Observation.	Description.	Name.
	α .	δ .				
97	300	-11	6	July 8-Aug. 15, 1902- 11	Bright; slowish; some trained. Greenish. Paths rather long. Mostly in July. Radiant well de- fined	α Capricornids
98	306	-17	3	July 24, 1900	Green; moderate; bright. Longish. Radiant well defined	„
99	314	+71	5	July 27-Aug. 16, 1911 and 1914	Short even when a long way from radiant; slowish; starlike. Radiant diffuse	ϵ Draconids
100	318	-9	10	July 28-Aug. 19	Slowish; rather long. Nearly entirely in August. Radiant diffuse, and ex- act place doubtful	β Aquarids
101	324	+10	12	July 24-Aug. 12, 1899- 1903	Very swift. White	ϵ Pegasids
102	330	+35	4	Mar. 29-Apr. 24, 1903	Slowish. Radiant well de- fined	π Pegasids
103	331	-12	5	July 27-30, 1911	Longish paths. No trains or streaks. Moderate. Stellar	ι Aquarids
104	337	-13½	5	July 27-Aug. 4, 1902- 3	Long. Rather swift	δ Aquarids
105	344	+46	9	July 28-Aug. 10, 1899	Rather swift; short; white; starlike; streaks	$\circ$ Andromedids
106	345	+1	6	Aug. 1-Oct. 2, 1899	Slowish. Mostly "thin"*	β Piscids
107	346	+1	6	July 30-Aug. 22, 1900	Slowish; mostly greenish and "thin." One trained	„
108	346	+1	8	July 28-Aug. 21, 1901- 10	Moderate or rather swift	„
109	346	+36	10	Aug.-Sept. 1899	Swift; white?	ι Andromedids
110	351	+53	4	July 22-Aug. 21, 1903	Slowish; short; faint	λ Andromedids
111	353	+27	6	July 24-28, Aug. 22, 1900	Swift. Radiant well defined	78 Pegasids
112	355	+77	10	July 27-Aug. 21, 1899- 1903	Very swift. Radiant well marked. Exactly on γ Cephei	γ Cepheids
113	357	+66	5	July 27-Aug. 18, 1899, 1902, 1915	Short; quick (flashing or "snappy"). White or bluish	$\circ$ Cepheids
114	358	+61	6	July 16-Aug. 12, 1900- 1903	Slowish; "thin"	β Cassiopeids
115	359	+59	5	July 28-Aug. 14, 1899	Slowish; "thin"	„
116	359	+59	6	Aug. 14-Sept. 21	Moderate	„
117	359	+1	5	July 26-Aug. 4, 1903	Rather swift; rather long	44 Piscids

* This refers to such bodies as have little or no apparent diameter, and unless carefully watched produce the appearance, due to persistence of vision, of thin lines across the sky. The term "stellar" might be used, but is liable to confusion with "starlike."

Notes on the Perseids.

Dates of Maximum.—The following are the dates of the maximum as determined in various years. In the missing years the materials were too scanty to indicate the epoch of maximum, owing usually to the sky having been obscured for several nights on and about the date :—

- 1899 Aug. 10.
- 1901 Aug. 11 or 12, probably 12.
- 1902 Aug. 11–12, probably Aug. 12.
- 1903 Aug. 12?
- 1904 Aug. 11 (early morning of 12th).
- 1907, probably Aug. 11.
- 1909 Aug. 11. Well marked. Observed in Holland.
- 1911, probably Aug. 12. Observed in Holland.
- 1914 Aug. 12, but only slightly stronger than on 11th.
- 1915 Aug. 12. Well marked.

The *strength* of the shower varies, too, year by year. In 1898 the display was decidedly strong; in 1899 fairly so. 1901 and 1902 brought returns of average strength. In 1904 the shower was again rather strong, while in 1907 it was not of normal activity. In 1909 the shower was pretty normal, but perhaps slightly weak. 1914 and 1915 produced weakish displays especially in 1915 (the latter as observed in Scotland).

In deducing these facts, due allowance has been made for the prevalence of bright moonlight and mist or cloud at about the time of maximum. It must not be forgotten, though, that difference of locality of observation may make a great difference in the observed strength of a given shower, since watchers widely separated see different sets of meteors.

Many of the Perseids are headed, and some trained, the trains generally having a central row of bright points, decreasing in size from head to tip. The shower usually furnishes a brighter display at and about the times of maxima.

The table below sets forth a comparison betwixt the observed places and those of an ephemeris of the shifting radiant given by Mr. W. F. Denning in 1901 (*Monthly Notices of the R.A.S.*, vol. lxii. p. 169). In working out the average positions, day by day, the radiants obtained in 1899 have been advanced a day, *i.e.* the position found on 1899 Aug. 9 has been averaged with those of Aug. 10 in other years, and so on. This is necessary owing to the lapse of a day in 1900.

Date.	Av. Position (A.K.)		No. of Radiants averaged.	Position (Ephemeris, W.F.D.).	
July 27	25°	+52°	1	27°·1	+53°·2
„ 27-28	28	+53	1	27°·7	+53°·4
Aug. 3	34°·8	+56	2	35°·1	+55°·3
„ 4	36	+57	1	36°·4	+55°·5
„ 6	38	+56°·5	1	38°·9	+56°·0
„ 9	42	+57	1	42°·9	+56°·7
„ 10	44	+57°·2	4	44°·3	+56°·9
„ 11	45°·4	+57°·4	5	45°·7	+57°·1
„ 12	47°·1	+57°·5	8	47°·1	+57°·3
„ 13	47°·7	+58°·3	3	48°·5	+57°·5
„ 14	48°·9	+58°·3	4	50°·0	+57°·7
„ 15	50°·5	+58°·5	2	51°·4	+57°·8

Mr. Denning remarks, in the place referred to above, that it is “quite possible that the radiant should be placed a little farther north, particularly at about the period of the maximum.” The mean declinations given in the second column above would certainly seem to bear out this statement.

Scunthorpe, N. Lincs. :
1916 April 3.